ACU Research Bank

Digital play in the early years : A systematic review

Item Type	Journal article
Authors	Chu, Celine;Paatsch, Louise;Kervin, Lisa;Edwards, Susan Elizabeth
DOI	10.1016/j.ijcci.2024.100652
Publisher	Elsevier B.V.
Download date	2026-11-19 05:06:57
Link to Item	https://hdl.handle.net/20.500.14802/15749

International Journal of Child-Computer Interaction 40 (2024) 100652

Contents lists available at ScienceDirect

International Journal of Child-Computer Interaction

journal homepage: www.elsevier.com/locate/ijcci

Research Paper

Digital play in the early years: A systematic review

Celine Chu [a,*], Louise Paatsch [b], Lisa Kervin [c], Susan Edwards [d]

[a] Faculty of Arts and Education, School of Education, Melbourne Burwood Campus, Victoria, 3125, Australia
[b] Faculty of Arts and Education, School of Education, Locked Bag 20000, Geelong, Victoria, 3220, Australia
[c] School of Education, Faculty of the Arts, Social Science and Humanities, Wollongong, New South Wales, 2522, Australia
[d] Faculty of Education and Arts, Learning Sciences Institute Australia, Victoria, 3065, Australia

1. Introduction

Children in their early years (birth-to-eight-years) are growing up in societies where networked digital technologies such as smartphones, tablets, computers, voice assistants, and internet-connected toys are not only commonplace, but central to social modes of communication and information sharing (Chaudron, Di Gioia, & Gemo, 2018). Prominently from 2010, following the release of the Apple iPad, touchscreen technologies, and more recently, voice assistants, have become embedded in the activities of many children and their families, enabling very young children to engage with the digital via touch and/or voice (Lowrie & Larkin, 2020). These advances in input, moving beyond using a keyboard and mouse as the primary form of interaction with the digital, mean that technologies increasingly enable young children's participation in their communities. Internationally recognised as the period between birth to eight years (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2022), many young children's early experiences of entertainment, recreation, household participation, and communication with family and friends involve using digital tablets (Arnott, Grogan, & Duncan, 2016), mobile phones (Herodotou, 2018), and Internet of Toys (Kewalramani & Havu-Nuutinen, 2019). Over time, as digital technologies have become integrated with young children's participation in society, a corresponding body of activity pertaining to young children's play with digital technologies, encapsulated in the notion of 'digital play' has emerged (e.g., Bird & Edwards, 2015; Fleer, 2014). Edwards (2023) describes three generations of thinking about young children's interactions with technologies through play. First generation thinking largely in the decades 1980 to early 2000s concerning children's use of digital technologies, second generation thinking since the 2010 advent of the iPad enabling increased independent digital activity by children, and third post-digital thinking considering the integration of technologies with children's socio-material activities. First generation thinking evolved from consideration of the earliest of technology use by young children using desktop computers and the extent to which these technologies were viewed as helpful or harmful to young children, while third generation thinking focuses on the socio-materiality of the digital as a form of post-digital activity. During this period of second generation thinking, a substantial body of literature about digital play has been generated that is the focus of this present review. Within this literature, significant attention has been directed towards the pedagogical use or application of digital play within children's educational experiences, in both Early Childhood Education and Care (ECEC) settings and the early years of school (EYS) (e.g., Amorim et al., 2022; Danby, Evaldsson, Melander, & Aarsand, 2018; Fantozzi, Johnson, & Scherfen, 2017; van der Westhuizen & Hannaway, 2021).

From a pedagogical perspective, digital play in the ECEC literature reflects the reliance placed on young children's play as primary mode of learning and development – particularly in Western-European approaches to early education. Here, the pedagogical role of play as a mode of exploration enabling children's interactions with the world, and with other people is positioned as a source for learning, and consequent developmental progression in much of the research about play-based learning, and in many curriculum frameworks internationally. As networked technologies became more socially prevalent in children's lives outside of ECEC, the imperative for this inclusion in ECEC has increased, and to accommodate this need pedagogically, research focussed on best understanding or interpreting digital play as a pedagogical construct (Edwards, 2023). Several studies, commencing from the 2010 launch of the Apple iPad, sought to examine digital play in this manner. For example, Fleer's (2014) research in an Australian childcare centre focused on the demands created from children's engagement with digital tablets that afford new possibilities for play and learning that could be described as digital play. Froes' (2015) study identified preschool children's emergent behaviours during playful interactions with digital tablets in a Danish kindergarten class by way of enhancing the use of tablets as a learning tool in schools as a recognisable form of play that essentially involved using technologies. A landmark paper by Marsh,

* Corresponding author.
E-mail addresses: celine.chu@deakin.edu.au (C. Chu), louise.paatsch@deakin.edu.au (L. Paatsch), lkervin@uow.edu.au (L. Kervin), Suzy.Edwards@acu.edu.au (S. Edwards).

https://doi.org/10.1016/j.ijcci.2024.100652
Received 22 August 2023; Received in revised form 28 November 2023; Accepted 19 March 2024
Available online 27 March 2024
2212-8689/© 2024 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

Plowman, Yamada-Rice, Bishop, and Scott (2016) sought to explain digital play as a category of play existing in its own right alongside well-known and traditionally accepted forms of play such as socio-dramatic play, rough and tumble play and locomotor play.

In addition to the research focussing on the ECEC setting, research about children's digital play in the early years of school (EYS) has examined the ways in which children's play with apps, tablets, digital games, and smart toys support children's learning, and encourage social interactions. Leung, Choi, and Yuen (2020) explored the role of video art technologies in school-aged children's play in supporting exploration, creativity, problem solving and imagination, and found that these technologies enhanced children's engagement in recognised forms of play. Dunn, Gray, Moffett, and Mitchell (2018) interviewed primary school children in Year 1 to Year 3 classes in five primary schools in Ireland and reported that children's use of tablet devices supported learning in a playful, fun, and engaging way. Other research has explored children's ability to use digital technologies to design and create digital content, outcomes which are often outlined in curriculum frameworks. Jarusriboonchai, Almeida, Meissner, and Balaam (2019) examined children's free play with digital technologies in four primary school classrooms in the UK. Findings showed that the children's digital play replicated known characteristics of children's play such as imitation, construction of different creations, parallel play, and group play, suggesting that digital technologies should be integrated into children's play and considered as another "component of children's wider play practices" (p. 10).

Research has also captured parents' perspectives about using technologies with children at home, and in the community. Erdogan et al.'s (2019) study examined parents' preferences and beliefs about their children's digital play. The study found that for parents in the USA, Turkey, China and South Korea, digital play was the least preferred play for their children compared to other play types such as constructive and physical play. Here, despite pedagogical positionings on research suggesting digital play was exploratory and offered a learning pathway for children like other play types, parents views were less favourable – tending to a preference for non-digital activities by children. Other research, involving children and families in digital play have examined home-based interventions to support children with learning difficulties (Lorusso, Biffi, Molteni, & Reni, 2018; Mairena et al., 2019; Sgandurra et al., 2016), explored children's digital play in the home (Given et al., 2016), and the role of parents in mediating children's digital play (Gozum & Kandir, 2021; Perone, Anderson, & Zelazo, 2021).

The growth in the digital play literature, from the 2010 release of the Apple iPad, to 2022 is substantial, with a simple Google Scholar search suggesting 7250 publication results for this term alone. While this growth in the literature has advanced some insights into how, where and why young children participate in play with technologies (e.g., Arnott, 2016), and the extent to which such play is afforded, constrained or enabled by their adults in any given social situation (e.g. Nevski & Siibak, 2016), little is known about the characteristic knowledge base informing this developing body of knowledge. For example, what does the extant literature suggest regarding the social or material affordances necessary for children to experience or participate in digital play in the first instance (e.g., what makes digital play possible)? What are the apparent or defining features of digital play? (e.g., what can educators, teachers, caregivers, and parents look towards as forms of digital play in action?), and what are the ongoing issues or concerns regarding children's digital play, in both formal and informal settings, and how are these likely impacted by ongoing digital advances in society? (e.g., AI, voice and facial recognition, robotics). Considering these concerns, this systematic review of the literature is predicated on the need to better understand the characteristic knowledge base of the available digital play literature over the past decade. The research question informing the review is "*What is the characteristic knowledge base of the digital play literature concerning young children aged birth to eight years since the 2010 release of the Apple iPad, up to 2022*?".

2. Methods

2.1. Search strategy

Four electronic academic database searches were performed in ProQuest, Scopus, Web of Science, and Education Research Complete. The searches were restricted to include peer-reviewed research articles published between 2011 and March 2022. To identify all the possible articles that focused on young children's (birth to 8 years) digital play in diverse settings, six search strings were composed according to the PICo (Population, Interest, Context) approach from the Cochrane Handbook (McKenzie et al., 2022). String 1 focused on children in ECEC settings, String 2 focused on search terms related to digital, String 3 focused on search terms related to play, String 4 focused on the early childhood settings, String 5 focused on children in school settings, and String 6 focused on the school settings.

Two sets of searches were conducted by using a combination of the six strings. The first search, performed to identify articles about children's digital play in early childhood settings, consisted of Strings 1, 2, 3 and 4: (child* OR "young child*" OR "early child*" OR infant OR toddler OR family* OR parent* OR "care giver" OR caregiver OR carer) AND (digi* OR tech* OR electronic OR screen) AND (play OR "play-based") AND (toy OR imagin* OR pretend OR game OR "game-based" OR gamif* OR drama* OR collab* OR language OR narrative OR character OR inquiry OR explor*) AND ("early childhood education" OR "early learning" OR "early years" OR "preschool" OR "pre-school" OR "child care" OR "family day care" OR "long day care" OR home). The second search, performed to identify articles about children's digital play in school settings, consisted of Strings 5, 2, 3 and 6: (child* OR student OR learner) AND (digi* OR tech* OR electronic OR screen) AND (play OR "play-based") AND (toy OR imagin* OR pretend OR game OR "game-based" OR gamif* OR drama* OR collab* OR language OR narrative OR character OR inquiry OR explor*) AND (primary school OR "elementary school" OR "first year of school"). The literature search yielded 4272 results, of which 1086 duplicate records were removed, resulting in 3186 articles.

2.2. Inclusion and exclusion criteria

Articles were assessed against the inclusion and exclusion criteria presented in Table 1. For inclusion, articles had to be peer-reviewed. Articles that were not peer-reviewed, such as grey literature, were excluded. In the case of conference proceedings, those with access to full texts were included in the initial searches but none met inclusion criteria for the purpose of analysis. Only articles published between 2011 and 2022 were included because this time span marked the release of the Apple iPad in 2010, and included emerging new technologies, such as

Table 1
Inclusion and exclusion criteria.

No	Inclusion criteria	Exclusion criteria
1	The article is peer reviewed.	The article is not peer reviewed (e.g., grey literature, conference proceedings that are not peer reviewed).
2	The article is published between 2011 and 2022.	The article is published before 2011.
3	The article is empirical research.	The article is not empirical research (e.g., theoretical works, reviews).
4	The article focuses on children from birth to 8 years of age.	The article focuses on children over 8 years of age.
5	The article has a strong focus on digital play and/or a connection with digital resources or experiences.	The article does not have a strong focus on digital play and/or a connection with digital resources or experiences.
6	The article is published in English.	The article is not published in English.

voice assistants, internet of toys and robotics. Articles not reporting on empirical research (e.g., theoretical works, systematic or scoping reviews), or articles not published in English, were excluded. Moreover, articles had to focus on children aged from birth to 8 years. Articles with children over 8 years were included if the mean age of the sample was 8 years or less. For the purposes of this review, to identify the characteristic knowledge base of digital play, included articles had to be strongly focused on digital play and/or a connection with digital resources or experiences. An article was included when it met all the six inclusion criteria. If an article met any one of the exclusion criteria, the article was excluded from the review.

The study selection was conducted in two steps by two reviewers (Author 1 [A1] and a research assistant), independently, on Covidence™ (www.covidence.org), a web-based collaboration software platform that supports the production of systematic reviews. In the first step, the titles and abstracts of each article were read, and the articles where both reviewers agreed did not fit the criteria were excluded. Where there was disagreement between the two reviewers, the reviewers discussed each difference by referring to the selection criteria until agreement was reached to include or exclude an article based on these criteria. Of the 3186 articles, 2642 articles were excluded based on screening the titles and abstracts. In the second step, full texts for the remaining articles were sought, after which both reviewers independently assessed relevancy of the full text articles based on the inclusion and exclusion criteria and followed by discussions to resolve any conflicts. The full texts for 544 articles were sought, of which 35 could not be retrieved. A total of 509 full-text articles were assessed for inclusion; 367 articles were further excluded according to the exclusion criteria. In all, 142 articles were included from the review process.

2.3. Methodological quality assessment

The methodological quality of all 142 articles was independently assessed by three authors (A1, A2, A4). The articles were classified into type of study design, including qualitative, quantitative, or mixed methods. Of the 142 articles, 69 were qualitative, 55 were quantitative, and 18 were mixed methods. Each article was then assessed using one of two quality assessment tools. Qualitative articles were assessed using The Standards for Reporting Qualitative Research (SRQR) checklist (O'Brien, Harris, Beckman, Reed, & Cook, 2014), which included six criteria for assessment of quality: (1) title and abstract; (2) problem formulation and research question; (3) research design and methods of data collection and analysis; (4) results and interpretation; (5) discussion, integration and limitations; and (6) other information. The checklist assesses whether the information is evident or not included in each article. Quantitative and mixed methods articles were assessed using the Mixed Methods Appraisal Tool (MMAT) (Hong et al., 2018), which included five methodological quality criteria listed under each category of studies (e.g., quantitative randomised controlled trials, quantitative non-randomised, quantitative descriptive, mixed methods). For each checklist item, a score of '1' (yes) or '0' (no) was assigned and an overall score out of 21 (for qualitative articles) and 5 (for quantitative and mixed methods articles) was tabulated. A fourth reviewer (A3) independently assessed 10% (15) articles using the same procedures. An inter-rater reliability of 80% was achieved which resulted in further discussions of the three articles where there was disagreement until the conflicts were resolved.

The quality scores of the qualitative articles ranged from 6 to 20 (out of 21), and from 1 to 5 (out of 5) for quantitative and mixed methods articles. All articles that did not meet quality assessment (n = 24) were excluded. A total of 118 articles including 54 qualitative articles with quality scores 11 and above, and 64 quantitative and mixed methods articles with quality scores 3 and above were included in the final review. Fig. 1 details the results and the reasons for exclusion at each stage of the review process, including identification, screening, and quality appraisal.

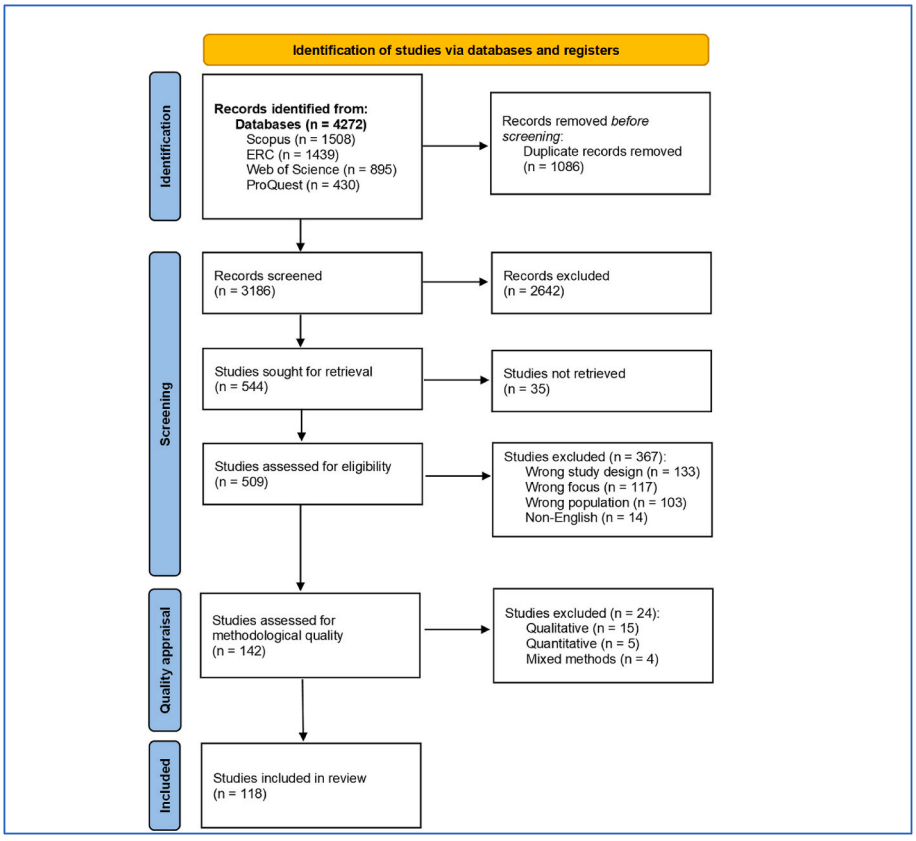


Fig. 1. Flow diagram of included studies.

2.4. Summary of included articles

Table 2 presents the 118 peer-reviewed articles that were included in this review. Each article is coded according to the type of research design (Design) and is identified using a unique study (ST) and identification number (e.g., ST-x).

2.5. Data extraction and analysis

The following information was extracted from each article: (a) authors; (b) year of publication; (c) title; (d) age of children; (e) participants and number; (f) the setting in which the study was conducted; (g) the country in which the study was conducted; and (h) data collection tools.

To establish the characteristic knowledge base of the digital play literature, an inductive analysis of the 118 articles was performed using the five phases of Braun and Clarke's (2006) thematic analysis, which were: 1) familiarising with data, 2) generating initial codes, 3) searching for themes, 4) reviewing themes, and 5) defining and naming themes. First, the articles were uploaded to the qualitative data analysis software NVivo. Each article was read to gain familiarity with the content and to generate initial themes that represented the features of digital play.

Table 2
Reviewed papers and identification numbers.

ID	Study	Design	ID	Study	Design
ST-1	Aarsand, Sorenssen (2021)	QL	ST-60	Lafton (2021)	QL
ST-2	Aberg, Lantz-Anderson, and Pramling (2015)	QL	ST-61	Lagerlof, Wallerstedt, and Pramling (2013)	QL
ST-3	Aguiar and Taylor (2015)	QT	ST-62	Laranjeiro (2021)	QL
ST-4	Alade, Lauricella, Beaudoin-Ryan, and Wartella (2016)	QT	ST-63	Lawrence (2018)	QL
ST-5	Alemi and Haeri (2020)	QT	ST-64	Lee and Wood (2021)	QT
ST-6	Alzubi, Fernandez, Flores, Duran, and Cotos (2018)	QT	ST-65	Leung et al. (2020)	QL
ST-7	Amorim et al. (2020)	QT	ST-66	Lim (2012)	QL
ST-8	Amorim et al. (2022)	QT	ST-67	Lorusso et al. (2018)	QT
ST-9	Arent, Kruk-Lasocka, Niemiec, and Szczepanowski (2019)	QL	ST-68	Lundtofte, Odgaard, and Skovbjerg (2019)	QL
ST-10	Arnott (2016)	QL	ST-69	Mairena et al. (2019)	QT
ST-11	Arnott et al. (2016)	QL	ST-70	Manessis (2014)	QT
ST-12	Axelsson, Andersson, and Gulz (2016)	QT	ST-71	Marklund (2022)	QL
ST-13	Aydin, Oflu, and Yalcin (2021)	QT	ST-72	Marsh (2017)	QL
ST-14	Bai et al. (2015)	QT	ST-73	Marsh et al. (2021)	MM
ST-15	Bang et al. (2019)	QT	ST-74	McKee and Heydon (2020)	QL
ST-16	Barnett, Hinkley, Okely, Hesketh, and Salmon (2012)	QT	ST-75	Mertala (2016)	MM
ST-17	Barsom and Ahmed (2021)	QT	ST-76	Miller (2018)	MM
ST-18	Bird, Edwards (2015)	QL	ST-77	Moawad (2017)	QT
ST-19	Byun and Seomun (2021)	QT	ST-78	Moore and Adair (2015)	QL
ST-20	Caceffo et al. (2022)	QT	ST-79	Murcia, Pepper, Joubert, Cross, and Wilson (2020)	QL
ST-21	Chmiliar (2017)	MM	ST-80	MuslimahSyamsudin (2020)	QL
ST-22	Coyle and Liben (2016)	QT	ST-81	Najoua and Mohamed (2020)	QT
ST-23	Danby, Davidson, Theobald, Houen, and Thorpe (2017)	QL	ST-82	Nilsen, Lundin, Wallerstedt, and Pramling (2021)	QL
ST-24	Danby et al. (2018)	QL	ST-83	Nuttall, Edwards, Lee, Mantilla, and Wood (2013)	MM
ST-25	Dias and Agante (2011)	QT	ST-84	Odgaard (2022)	QL
ST-26	Disney and Geng (2017)	QL	ST-85	Oliemat et al. (2018)	QL
ST-27	Dore et al. (2019)	QT	ST-86	Oqvist and Hogstrom (2018)	QL
ST-28	Dunn et al. (2018)	QL	ST-87	Palaiologou, Kewalramani, and Dardanou (2021)	QL
ST-29	Eckhoff (2017)	QL	ST-88	Peppler, Wohlwend, Thompson, Tan, and Thomas (2019)	MM
ST-30	Elimelech and Aram (2019)	QT	ST-89	Perone et al. (2021)	QT
ST-31	Erdogan, Johnson, Dong, and Qiu (2019)	MM	ST-90	Pila, Piper, Lauricella, and Wartella (2020)	QT
ST-32	Fang, Tapalova, Zhiyenbayeva, and Kozlovskaya (2022)	QT	ST-91	Putnam, Cotto, and Calvert (2018)	QT
ST-33	Fantozzi et al. (2017)	QL	ST-92	Ronimus, Eklund, Pesu, and Lyytinen (2019)	QT
ST-34	Fridin (2014)	QT	ST-93	Rosa, Ridgers, and Barnett (2013)	QT
ST-35	Given et al. (2016)	QL	ST-94	Russo-Johnson et al. (2017)	QT
ST-36	Gou and Dezuanni (2018)	QT	ST-95	Sakr and Scollan (2019)	QL
ST-37	Gozum, Kandir (2021)	MM	ST-96	Sanchez-Morales, Durand-Rivera, and Martinez-Gonzalez (2020)	MM
ST-38	Gulliford, Walton, Allison, and Pitchford (2021)	QL	ST-97	Schacter et al. (2016)	QT
ID	Study	Design	ID	Study	Design
ST-39	Gulz, Londos, and Haake (2020)	QT	ST-98	Schenke et al. (2020)	QT
ST-40	Han et al. (2015)	QT	ST-99	Sgandurra et al. (2016)	MM
ST-41	Herodotou (2018)	QT	ST-100	Shoshani, Nelke, and Girtler (2022)	QT
ST-42	Ho, Lee, Wood, Kassies, and Heinbuck (2018)	QT	ST-101	So et al. (2019)	MM
ST-43	Hollenstein, Thurnheer, and Vogt (2022)	MM	ST-102	So et al. (2020)	QT
ST-44	Howie, Coenen, Campbell, Ranelli, and Straker (2017)	QT	ST-103	Sosa (2016)	QT
ST-45	Huh (2017)	QL	ST-104	Sundqvist (2021)	QL
ST-46	Isikoglu, Erol, Atan, and Aytekin (2021)	QL	ST-105	Taheri, Meghdari, Alemi, and Pouretemad (2018)	MM
ST-47	Jarusriboonchai et al. (2019)	QL	ST-106	van der Westhuizen, Hannaway (2021)	QL
ST-48	Johnston, Highfield, and Hadley (2018)	QL	ST-107	Verdine et al. (2019)	QT
ST-49	Kalabina and Progackaya (2021)	QL	ST-108	Verenikina and Kervin (2011)	QL
ST-50	Karno and Hatcher (2020)	QL	ST-109	Verenikina, Siraj, and Kervin (2018)	QL
ST-51	Kervin (2016)	QL	ST-110	Vogt and Hollenstein (2021)	QL
ST-52	Kervin, Verenikina, and Rivera (2018)	QL	ST-111	Wohlwend (2017)	QL
ST-53	Kewalramani and Veresov (2021)	QL	ST-112	Wooldridge and Shapka (2012)	QT
ST-54	Kewalramani et al. (2020)	QL	ST-113	Wu et al. (2014)	QT
ST-55	Kewalramani, Kidman, and Palaiologue (2021)	QL	ST-114	Yalcin et al. (2021)	QT
ST-56	Kewalramani, Veresov (2021)	QL	ST-115	Yasbiati, Gandana, and Rahman (2019)	QT
ST-57	Kewalramani, Palaiologue, et al. (2021)	QL	ST-116	Yelland and Gilbert (2018)	QL
ST-58	Kim and Tscholl (2021)	QL	ST-117	Yilmaz (2016)	MM
ST-59	Kumpulainen, Byman, Renlund, and Wong (2020)	QL	ST-118	Zippert, Daubert, Scalise, Noreen, and Ramani (2019)	QT

Authors 1, 2 and 4 met to establish initial inductive codes resulting in the development of an early code book. These authors met again on at least two occasions to check coding against agreed definitions. Definitions for themes and sub-themes were confirmed. Author 3 then tested these agreed codes on a sample set of data (10%). Upon confirmation that the tested codes were aligned with the final code book, Author 1 coded all papers. Finally, all researchers agreed on three levels of themes: (1) main theme; (2) theme; and (3) sub-themes.

3. Findings

The findings of this review are presented in two main sections. The first section provides a summary of the 118 reviewed articles comprising details of each study including year of publication, country where the study took place, participant group, setting, and data source. The second section describes the identified main themes, themes, and sub-themes establishing the characteristic knowledge base of the digital play literature 2010–2022. There were three main themes identified in this review which were: (1) affordances for digital play, (2) features of digital play, and (3) concerns about digital play. The overall findings suggest a trend in the digital play literature towards a reliance on theories of play, learning and development.

3.1. Summary of the reviewed articles

The combined characteristics of the 118 articles included in this review are provided in Table 3. In summary, studies were conducted in United States (19%), Australia (16%), Sweden (7%), United Kingdom (6%), Canada (5%), Turkey (4%), Korea (3%), Hong Kong (3%), Finland (2.5%), Brazil (2.5%), Israel (2.5%), Norway (1.5%), Scotland (1.5%), Denmark (1.5%), Indonesia (1.5%), Switzerland (1.5%), Spain (1.5%), Portugal (1.5%), Iran (1.5%), Russia (1.5%), China (1%), Italy (1%), Poland (1%), Ireland (1%), Greece (1%), Saudi Arabia (1%), Egypt (1%), Jordan (1%), Mexico (1%), South Africa (1%). Five articles each conducted their studies across different countries including Australia/Norway/Sweden, Australia/Norway/Scotland/United Kingdom, United Kingdom/Australia, United States/Turkey/China/Korea, and Italy/Denmark. The review captured studies involving children (103 studies) including pre-term infants, children from English and non-English speaking backgrounds, low to high socioeconomic backgrounds, or diagnosed with health conditions such as autism, developmental disabilities, or language impairment. Other participant groups captured in this review using the search strings were parents (26 studies), early years staff including centre directors (23 studies), student teachers (3 studies), and a psychiatric specialist (1 study). Data were predominantly collected from formal education settings such as ECEC services and primary schools (56%), with twenty-four (20%) studies capturing data from families' homes, fifteen (13%) studies from laboratory or experimental conditions, five (4%) studies from healthcare settings such as hospitals, clinics, special care centres, and three (2.5%) studies from other public spaces such as museums, markets, gyms, beauty salons. These findings show that the range of participants and settings captured in these 118 included papers is diverse despite the search strings focussing on ECEC settings and early years of school (EYS). This diversity suggests the presence of digital play in many aspects of young children's lives despite the pedagogical adaptation of digital play for learning in ECEC and the EYS. Most of the studies (66%) used observations for data collection, which includes the use of field notes, photographs, video- and audio-recordings and checklists. Other data collection methods were interviews (36 studies), surveys or questionnaires (33 studies), pre- and post-tests or assessments (30 studies), artefacts (21 studies), and researcher-led activities (2 studies).

Table 3
Combined details of the 118 articles included in this review.

Details	Number of articles reporting (% of overall archive)
Year of publication	
2011–2015	17 (14.5%)
2016–2020	71 (60%)
2021	23 (19.5%)
2022	7 (6%)
Country (of study)	
United States	22 (19%)
Australia	19 (16%)
Sweden	8 (7%)
United Kingdom	7 (6%)
Canada	6 (5%)
Turkey	5 (4%)
Korea, Hong Kong	4 in each country (6%)
Finland, Brazil, Israel	3 in each country (7.5%)
Norway, Scotland, Denmark, Indonesia, Switzerland, Spain, Portugal, Iran, Russia	2 in each country (13.5%)
China, Italy, Poland, Ireland, Greece, Saudi Arabia, Egypt, Jordan, Mexico, South Africa	1 in each country (10%)
Australia/Norway/Sweden	1 (1%)
Australia/Norway/Scotland/United Kingdom	1 (1%)
United Kingdom/Australia	1 (1%)
United States/Turkey/China/Korea	1 (1%)
Italy/Denmark	1 (1%)
Not stated	1 (1%)
Participant group	
Children	103 (87%)
Parents	26 (22%)
Early years staff (including teachers, educators, service directors)	23 (19.5%)
University students/future teachers	3 (2.5%)
Psychiatric specialist	1 (1%)
Setting (of study)	
Early childhood services, schools, tertiary institutions (e.g., primary/elementary schools, preschools, kindergartens, childcare/day care centres, playgroups, university-based preschools, teacher education program in universities)	66 (56%)
Families' homes (including through telephone/Skype/Zoom)	24 (20%)
Laboratory/Experimental conditions (including university-based laboratories and workshops, laboratory playrooms)	15 (13%)
Hospitals, clinics, special care centres	5 (4%)
Other (e.g., public spaces including museums, markets, gyms, beauty salons)	3 (2.5%)
Data source	
Observations (including field notes, photographs, video and audio recordings, checklists)	78 (66%)
Interviews (including focus groups, discussions, conversations/informal talks)	36 (30.5%)
Surveys or questionnaires (including demographic)	33 (28%)
Pre- and post- tests or assessments (including skill and behaviour measures/assessments using a range of devices)	30 (25%)
Artefacts (e.g., learning stories, iPad diaries, image and videos created by children, screen-recordings, multimedia messages, child-led tours of iPads, classroom map, planning and assessment records, written reflections)	21 (18%)
Researcher-led activities (e.g., storyboards, games)	2 (2%)

3.2. Main themes, themes, and sub-themes

Table 4 presents the overview of the main themes, themes, and sub-themes identified in the review of 118 articles. The three main themes were: (1) affordances for digital play, (2) features of digital play, and (3) concerns about digital play. The first main theme consisted of one theme and six sub-themes. The second main theme included six themes and thirteen sub-themes. The final main theme comprised of one theme and

Table 4
Main themes, themes, and sub-themes addressing the research question "What is the characteristic knowledge base of the digital play literature?"

Main theme	Theme	Sub-theme
1. Affordances for digital play	Involving the use of device or technology	Types of electronic and non-electronic equipment (including non-working technologies)
		Access to devices
		The use of apps and information about apps
		Competency
		Portability
		Ease of use
2. Features of digital play	Learning and development	Learning
		Creativity
		Pretend play
		Problem-solving
	Situated	Adult perspectives and decision-making
		Rules
	Interactive	Actions and interactions
	Enjoyable and entertaining	Enjoyment
		Entertainment
	Meaningful	Children's agency and control
		Intentional
		Competition
	Gendered	Female or male characteristics
3. Concerns about digital play	Risks	Effects on health and behavioural development

one sub-theme.

Table 5 summarises the distribution of articles from the 118 reviewed articles across the three identified main themes and eight themes.

Tables 6–8 presents the sub-themes relating to each of the themes, including the number of studies and percentages that were identified for each theme and sub-theme. The percentages presented under each theme represent the number of identified studies out of the 118 reviewed articles, whereas the percentages reported about each sub-theme represent the number of identified studies within each theme.

3.3. Affordances for digital play

The first main theme identified in the review included 110 (93%) articles that indicated digital play could not occur without children having access to, or using, a device or technology. Further analysis of these articles identified six sub-themes pertaining to the use of a device or technology as a necessary affordance for digital play. Table 6 presents these sub-themes in order of decreasing frequencies including: *Types of electronic and non-electronic equipment (including non-working technologies)* (73%), *Access to devices* (24.5%), *The use of apps and information about apps* (24%), *Competency* (11%), *Portability* (4.5%), and *Ease of use* (3%).

Eighty (73%) studies described the *Types of electronic and non-electronic equipment* such as tablets (ST-4), computers (ST-36), robots (ST-9), augmented reality (ST-14), game consoles (ST-16), smartphones (ST-19), and non-working laptops and wooden pretend tablets (ST-43). Twenty-seven (24.5%) studies reported about *Access to devices* as an important affordance for digital play. For example, ST-28 found that tablet devices were commonly available in the homes of many children and that they were mainly used for playing games, taking photos, and watching YouTube and Netflix. Twenty-six (24%) studies reported about *the use of apps and information about apps*. For example, ST-35 described the types of play enabled by children's use of information technology. Specifically, the study documented a child's use of a drawing app and how the app supported the child's engagement with artistic play. *Competency* was indicated by 12 studies (11%) as an affordance for digital play. While most of these studies reported that children were capable users of devices and technology (e.g., ST-49, ST-50, ST-52, ST-67, ST-73, ST-80, ST-83, ST-85), some studies indicated that children's play with digital was affected by their skill level in operating a device (e.g., ST-75, ST-76, ST-78). Five studies (4.5%) indicated that the *Portability* of devices uniquely afforded digital play to happen in different places (e.g., homes, gardens, cars – ST-85, ST-28) and at different times of the day (e.g., on the way to school – ST-85). Three (3%) studies highlighted that tablet devices were easy to use, enabling even very young children to engage in digital play. For example, ST-71 pointed out that the touchscreen feature of tablets, rather than the use of a mouse and keyboard, contributes to its *ease of use*. Similarly, ST-38 described that the use of visuals, via icons and the reduced need for typing via audio instruction affording digital play opportunities, especially those children with emergent written literacies.

3.4. Features of digital play

The second main theme in the 118 articles identified six main features of digital play (1) *Learning and development*, (2) *Situated*, (3) *Interactive*, (4) *Enjoyable and entertaining*, (5) *Meaningful*, and (6) *Gendered* (see Table 6).

Within the first of these features, *Learning and development*, a further four sub-themes were identified including *Learning*, *Creativity*, *Pretend Play*, and *Problem solving*. Table 7 presents these sub-themes, and the number and percentage of articles within the theme. The sub-theme *Learning* was reported in 63 (77%) studies. Examples in this area included opportunities for children to acquire knowledge and skills using digital technologies, such as reading and writing (ST-7), object control skills (ST-16), and gaze-shifting in children living with autism (ST-105). Seventeen (21%) studies reported about *Creativity* such as using digital to record images of themselves and their surroundings for creating augmented (ST-59) and digital self-stories (ST-26). Twelve (15%) studies reported the use of digital enhanced *Pretend play* by providing a virtual space that enabled children to move between real object play and imaginative play (ST-61, ST-72). Eight (10%) studies reported on *Problem solving*, where children were invited to find solutions to technological issues in their play such as devices failing to work (ST-43), debugging, or designing devices for specific purposes (ST-84).

The second theme featured digital play as *Situated* (61 studies; 52%). Further analysis of this theme identified two sub-themes: (1) *Adult perspectives and decision-making*; and (2) *Rules*. Forty-nine (80%) studies reported that *adult perspectives and decision-making* influenced digital activities enacted with children with hardware and software. For example, ST-46 found that parents who believed that digital play was beneficial for their children tended to allow their children to use devices more frequently and for longer periods of time. Similarly, ST-13 also found that parents tended to limit their children's video-game play based on their views on screen use limitation. Furthermore, ST-43 reported that teachers' presence during digital play provided guidance for children's engagement with more complex reasoning around digital processes. In the sub-theme *Rules*, 26 (43%) studies reported about rules associated with device use resulting from different contexts or cultures. For example, ST-26 found that young children in Shanghai tended to spend more time on tablets, compared with other districts, due to Shanghainese parents having adopted more open attitudes toward new technologies than parents in other districts of China. ST-28 also found that children were often aware of the different rules associated with device use between home and at school, such as not being allowed to download materials when using iPads at school.

The third feature of digital play evident in the archive was *Interactive* (37 studies; 31%), which included *Actions and interactions* (100%) comprising what children and adults do and say during technology use, and when using hardware and software. Such interactions between a group of children and technologies were presented as being cooperative, such as when children worked cooperatively on a tablet device to create a story (ST-2), or non-cooperative, such as grabbing the device, blocking visibility and exclamations about unfairness (ST-63). Actions and

Table 5
Identified main themes and themes from the reviewed articles.

Main theme	Affordances for digital play	Features of digital play						Concerns about digital play
Theme Article	Involving the use of device or technology	Learning and development	Situated	Interactive	Enjoyable and entertaining	Meaningful	Gendered	Risks
ST-1	X		X	X		X		
ST-2	X	X		X		X		
ST-3	X				X			
ST-4	X	X						
ST-5	X	X						
ST-6	X	X						
ST-7	X	X						
ST-8		X						
ST-9	X	X		X				
ST-10			X	X		X		
ST-11	X	X	X		X	X		
ST-12	X	X					X	
ST-13	X		X				X	
ST-14	X	X	X		X			
ST-15	X	X						
ST-16	X	X						
ST-17			X					
ST-18	X	X						
ST-19	X				X			
ST-20	X			X		X		
ST-21	X	X	X					
ST-22	X						X	
ST-23	X	X						
ST-24	X			X				
ST-25	X	X				X		
ST-26	X	X	X		X	X		
ST-27	X	X						
ST-28	X	X	X		X	X		
ST-29	X	X						
ST-30	X	X						
ST-31	X	X	X					X
ST-32	X	X						X
ST-33	X	X	X	X		X		
ST-34	X	X			X			
ST-35	X	X				X		
ST-36	X		X					
ST-37	X	X	X			X	X	
ST-38	X	X	X			X		
ST-39	X	X						
ST-40	X				X		X	
ST-41	X	X						
ST-42	X		X	X				
ST-43	X	X	X					
ST-44	X							X
ST-45	X		X	X		X		
ST-46	X	X	X		X	X		X
ST-47	X		X			X		
ST-48	X	X	X					X
ST-49	X		X		X			
ST-50	X	X		X				
ST-51	X	X		X				
ST-52	X	X	X	X	X	X		X
ST-53			X					
ST-54				X				
ST-55	X	X		X		X		
ST-56	X	X	X	X				
ST-57	X	X	X					
ST-58	X	X		X	X	X		
ST-59	X	X	X			X		
ST-60	X	X	X					
ST-61	X	X	X	X	X	X		
ST-62	X	X	X		X			
ST-63	X	X	X	X	X	X		
ST-64	X		X	X				
ST-65	X					X		
ST-66	X		X	X	X			
ST-67	X	X						
ST-68	X		X	X	X	X		
ST-69	X	X						
ST-70			X					
ST-71	X	X	X					

(*continued on next page*)

Table 5 (*continued*)

Main theme	Affordances for digital play	Features of digital play						Concerns about digital play
Theme Article	Involving the use of device or technology	Learning and development	Situated	Interactive	Enjoyable and entertaining	Meaningful	Gendered	Risks
ST-72	X	X		X		X	X	
ST-73	X	X	X		X			
ST-74	X	X	X					
ST-75	X	X	X		X	X		
ST-76	X	X	X	X	X	X		
ST-77	X				X			
ST-78	X	X	X	X	X	X		
ST-79	X	X	X			X		
ST-80	X	X	X		X	X		X
ST-81	X	X						
ST-82	X		X	X		X		
ST-83	X			X	X			
ST-84	X	X		X		X		
ST-85	X	X	X		X		X	
ST-86	X	X	X					
ST-87	X	X				X		
ST-88		X						
ST-89	X	X	X					
ST-90	X	X						
ST-91	X	X						
ST-92	X	X						
ST-93	X	X						
ST-94	X	X				X	X	
ST-95	X		X	X		X		
ST-96	X					X		
ST-97	X	X					X	
ST-98	X	X						
ST-99	X	X						
ST-100	X	X						
ST-101	X	X						
ST-102	X	X						
ST-103	X		X	X				
ST-104	X	X	X					
ST-105	X	X	X		X			
ST-106	X	X	X					
ST-107	X		X					
ST-108	X	X	X	X	X	X		
ST-109	X		X	X				
ST-110	X	X	X	X				
ST-111	X	X	X	X	X			
ST-112	X		X	X				
ST-113	X		X					X
ST-114	X		X				X	
ST-115	X	X						
ST-116	X	X	X	X	X	X		
ST-117	X			X	X			
ST-118			X	X				
Total	110	82	61	37	30	37	10	8

interactions also included those between a child and device, such as when the child played a game of Fruit Ninja and was invited in the game to start over when his avatar died (ST-68).

Digital play was also featured as *Enjoyable and entertaining* (30 studies; 25%). Twenty-five (83%) studies reported that digital play was *Enjoyable*. Examples from this sub-theme included studies that reported that children enjoyed interacting with robots (ST-34), and children preferred the augmented reality system to non-AR systems (ST-14). Six (20%) studies reported that digital play was *Entertaining*, with children indicating their favourite activities were using a range of devices for gaming, video-watching, and filmmaking (ST-80, ST-111).

The fourth theme evident in the data featured digital play as *Meaningful* (37 studies; 31%) for many children. Within this theme, three further sub-themes were identified. First, digital play provided opportunities that supported *Children's agency and gave them a sense of control* (20 studies, 54%; e.g., ST-45, ST-87, ST-108). For example, ST-45 described how a child's game play during a car ride gave him a form of control, through his car-racing game, over his relatively powerless reality of being strapped in the car back seat. Similarly, ST-87 found that children would often use the pre-programmed functions in Internet of Toys, and in addition, created their own rules and play scenarios by way of maintaining control of their imaginative play episodes. Second, nineteen (51%) studies indicated that children initiated *Intentional* acts with devices to fulfil specific purposes. Some of these acts were in relation to important events in children's lived experiences such as when a child chose to record videos of her pets for digital storytelling because her pet cat had recently died (ST-26), or a child who found comfort in recording journal entries about her mother on a tablet device at preschool by way of managing her feelings from being away from her mother. The third sub-theme highlighted that some children engaged in *Competitions* (4 studies, 11%) during digital play such as in the numeracy App Mathletics where children are challenged to move up levels or win prizes (ST-28).

The final theme identified as a feature of digital play suggested *Gendered* dimensions, with *female and male characteristics* attributed to use of digital (10 studies; 8.5%). Examples in this area included preferences for certain game-types, with female children reportedly preferring such games as dressing-up and princesses, while male children

Table 6
Affordances for digital play.

Theme (number and % of overall archive)	Sub-theme	Number of studies indicating (% within each theme)
Involving the use of device or technology (n = 110; 93%)	Types of electronic and non-electronic equipment (including non-working technologies)	80 (73%)
	Access to devices	27 (24.5%)
	The use of apps and information about apps	26 (24%)
	Competency	12 (11%)
	Portability	5 (4.5%)
	Ease of use	3 (3%)

Table 7
Features of digital play.

Theme (number and % of overall archive)	Sub-theme	Number of studies indicating (% within each theme)
Learning and development (n = 82; 69%)	Learning	63 (77%)
	Creativity	17 (21%)
	Pretend play	12 (15%)
	Problem-solving	8 (10%)
Situated (n = 61; 52%)	Adult perspectives and decision-making	49 (80%)
	Rules	26 (43%)
Interactive (n = 37; 31%)	Actions and interactions	37 (100%)
Enjoyable and entertaining (n = 30; 25%)	Enjoyment	25 (83%)
	Entertainment	6 (20%)
Meaningful (n = 37; 31%)	Children's agency and control	20 (54%)
	Intentional	19 (51%)
	Competition	4 (11%)
Gendered (n = 10; 8.5%)	Female or male characteristics	10 (100%)

Table 8
Concerns about digital play.

Theme (number and % of overall archive)	Sub-theme	Number of studies indicating (% within each theme)
Risks (n = 8; 7%)	Effects on health and behavioural development – e.g., distraction, addiction, violence, lack of physical activity, self-regulation	8 (100%)

reportedly preferred car and war games (ST-85), and habitual behaviours associated with self-regulation such as tapping frequency, with males found to tap significantly more than females during the instructional parts of an App (ST-94).

3.5. Concerns about digital play

The final main theme identified in the 118 articles related to studies that indicated *Concerns* about digital play, by way of the associated *Risks* (8 studies; 7%) resulting from children's use of a device or technology (see Table 8). All eight studies (100%) reported about the *Effects on children's health and development* such as the lack of physical activity (ST-31, ST-44), distraction (ST-31, ST-48, ST-52), addiction (ST-31), violence (ST-31, ST-32, ST-46, ST-113), the lack of self-regulation (ST-31, ST-32, ST-46), vision problems (ST-31, ST-80), and the lack of social interaction (ST-32, ST-48, ST-113).

4. Discussion

The increased use of digital technology by young children since the 2010 release of the Apple iPad, through to 2022 has generated a very large body of literature about digital play. However, what is known in a summative sense from this literature is not well established, leaving stakeholders concerned with the digital play activities of young children with little sense of direction as to what constitutes digital play, and any likely issues or concerns associated with children's digital play. This systematic review of the literature, therefore, asked the primary research question: "*What is the characteristic knowledge base of the digital play literature concerning young children aged birth to eight years since the 2010 release of the Apple iPad, up to 2022?*"

This review confirms that there is indeed a substantial body of literature regarding young children's digital play from 2010 onwards, as demonstrated in the 4272 records that were initially identified from four databases via the search process. Following further screening and quality appraisal processes, 118 empirical research articles published between 2011 and 2022 were confirmed for this review. Most of these articles were published from 2016 onwards (2016–2020: 60%; 2021: 19.5%; up to March 2022: 6%), likely because it took some five to six years for research about young children's use of Apple iPads to be conducted and published following its 2010 release, as well research about subsequent digital technologies such as smartphones and internet-connected toys. Moreover, apart from the sheer volume of research, there is evidence that digital play is a topic of interest across many countries (e.g., United States, Australia, Sweden, United Kingdom, Hong Kong, Turkey, Israel, and Korea).

In addition to identifying the quantity of digital play literature, this review has established three key findings representing the characteristic knowledge base of the digital play literature 2010–2022 – confirmed for inclusion in this review via quality appraisal. These three findings are: (1) *Affordances for digital play*, (2) *Features of digital play*, and (3) *Concerns about digital play*. Collectively, these three findings suggest that what is known about digital play from this body of digital play research conducted since the 20,210 release of the Apple iPad, includes what is necessary to afford digital play as an activity or participatory opportunity for young children in the first instance, the features of digital play as enacted by children and those around them, and ongoing concerns about young children's participation in digital play, notably in terms of health or notions of addiction.

The first finding establishes affordances for digital play, which primarily involves the use of a device or technology by young children birth to 8 years (n = 110; 93%). The six sub-themes identified within this set of findings further informed the affordances for digital play. These included the *types of electronic and non-electronic equipment (including non-working)* (73%), *access to devices* (24.5%), *use of apps and information about apps* (24%), *competency* (11%), *portability* (4.5%), and *ease of use* (3%). These affordances identified in this review confirm that digital play is contingent on some form of interaction with the digital to be considered more than play without technologies. Interestingly, the digital in this aspect does not have to include working technologies, with children's interactions with non-working technologies including pretend 'representative' technologies (e.g., a block as a smartphone) for play recognised as an affordance for digital play. This finding raises questions about the under-theorisation of the concept of the 'digital' as applied to digital play, especially in early education settings where ongoing concern about the appropriateness of digital play for young children as being too abstract over the value of hands-on learning, may be mediated by affordances for digital-like play, especially in a pretend sense. For example, a socio-material perspective of the digital as either involving children's interactions with working technologies, or pretend, 'representative' technologies relate to concepts of the post-digital whereby the social and technological are considered inter-related (Marsh, 2019). Here appreciation for pretend digital play by children as a post-digital mode of meaning-making about their lives is indicated,

whereas other sub-themes in the affordance finding highlight access to working technologies, and how digital play with working technologies is consequently informed by the portability of devices and children's capacity to operate devices themselves. For example, it was found that less competent users were often discouraged from engaging in digital play.

The second finding established the primary features of digital play characterised within the digital play literature. These features are *learning and development* (69%), *situated* (52%), *interactive* (31%), *enjoyable and entertaining* (25%), *meaningful* (31%), and *gendered* (8.5%). A further thirteen sub-themes were identified pertaining to the six features. In the main, these features reflect already known dimensions of children's play, especially according to developmental and constructivist theoretical perspectives in which play is associated with learning and development (e.g., Aarsand & Sorenssen, 2021; Bai, Blackwell, & Coulouris, 2015; Kewalramani & Havu-Nuutinen, 2019), and socio-cultural perspectives in which play is considered culturally situated (e.g., Fantozzi et al., 2017; Marsh et al., 2021). Interactivity, enjoyment and entertainment, and play as meaningful are likewise extensively evident in non-digital play accounts of play (Henricks, 2008). Drawing on these theoretical perspectives most of the articles explored digital play as opportunities for enhancing young children's learning and development (n = 82; 69%). Specifically, it was found that digital play promotes young children's *learning* (77%), *creativity* (21%), engagement in *pretend play* (15%), and *problem-solving* (10%). These findings suggest that digital play research, in general, is shaped by broader understandings of play portrayed in early childhood research, rather than any accounts, or explanations of the digital or technological (Edwards, 2021). This situation may have occurred given play is a highly valued mode of learning in early childhood (Grieshaber & Barnes, 2021), and as researchers have sought to understand the broader remit of digital play they have defaulted primarily to existing understandings of play. Here, the features of digital play, following the affordances for digital play in this review of the literature, suggest digital play is only possible in relation to the digital (working or non-working), and is primarily understood as a form of socio-constructivist activity supporting young children's learning and development through situated, enjoyable, and meaningful activities. Defined as such, digital play is primarily presented in the extant literature as young children interacting with working or non-working technologies as an enjoyable activity orientated towards learning and development.

Gender is also indicated as a sub-set consideration in this view of digital play where most of the articles explored gender differences in children's preferences for games and Apps as well as differences in levels of engagement and learning during play with technologies. Han, Jo, Hyun, and So (2015), for example, explored whether gender related to differences in 5- and 6-year-old children's perceptions with AR-infused dramatic play in relation to satisfaction and sensory engagement, and empathy with media, reporting higher levels of media empathy in females compared to males. Oliemat, Ihmeideh, and Alkhawaldeh (2018) reported differences between males and females in digital game preferences across three age groups (4–5 years; 6–7 years; and 7–8 years), where females preferred dress up games compared with males who preferred car, war, wrestling and amusement games. Russo-Johnson, Troseth, Duncan, and Mesghina (2017) reported that females preferred to drag objects compared to males who preferred to watch and tap screens as they learnt novel object labels. These findings suggest that digital play preferences and habitual behaviours, are shaped by the broader literature on gender in relation to children's differential engagement and personal interests in objects and activities.

The final finding suggests that concerns about digital play is characteristic of the extant digital play literature. Compared to most studies that focused on the features of digital play (e.g., learning and development), fewer studies (n = 8; 7%) explored concerns about digital play. One reason for a lack of research in this area could be that the body of work focussing on the features of digital play indicates so many features positively associated with play itself (e.g., interactive, enjoyable, meaning-making) that concerns are not predominate in the theoretical application of play to the digital in the first instance. However, with the increasing possibilities arising from new technological advancements such as artificial intelligence (AI), voice and facial recognition, a continued focus on digital play via historically valued concepts of play may be insufficient to identify any concerns with digital play, or at least in practice identify potential issues adult educators and caregivers should be alert to when young children are participating in digital play. This may include for example, awareness of young children's online safety when using networked technologies, supporting children to understand how AI intercedes in technological decision making and fostering concepts of digital data and approaches to data literacy with young children within the context of digital play.

4.1. Limitations of this review

This review has several limitations despite adopting a systematic approach when carrying out the review process and completing quality appraisals of the included literature. First, the exclusion of non-peer reviewed literature, non-empirical research studies, and studies that were reported in languages other than English means that relevant studies may have been missed. Second, four electronic databases that covered a range of academic fields were searched, therefore articles from other databases may have unintentionally been excluded. Third, despite consultations with experts in the field and university librarians, the selection and use of search terms may have resulted in exclusion of relevant research articles. Finally, most of the studies included in this review were conducted in Western contexts - United States and Australia. This potential cultural bias should be taken into consideration when making generalisations from the findings presented in this review which may be primarily applicable to research in these settings.

5. Conclusion

This systematic review aimed to provide insight into the extant literature which explored young children's digital play following the release of the Apple iPad in 2020. Specifically, this review sought to identify the characteristic knowledge base of digital play for young children in the available literature. Findings from this review revealed a large body of research investigating children's digital play across many countries. This paper has highlighted three key findings that represent the characteristic knowledge base of the digital play literature following the release of the Apple iPad. These include that: 1) digital play is only possible when children are afforded by access to working or non-working technologies; 2) there appears to be six distinctive features of digital play including learning and development, situated, interactive, enjoyable and entertaining, meaningful, and gendered; and 3) there remains concerns about the effects of digital play on young children particularly in relation to physical activity and addiction.

The first finding is somewhat intuitive in that digital play is only possible when afforded by access to the digital in either non-working or working form, although the inclusion of non-working technologies and the use of 'representative' technologies in these findings suggests the ongoing imbrication of the digital in children's social practices, especially in pretend play that encompasses a forward movement towards post-digital thinking (Marsh, 2019). The second finding is interesting in that despite social and technological advances in technologies, ECEC and EYS research tends to rely upon and continues to use theories of play, learning and development to characterise, define and explain digital play, with limited engagement of alternative theoretical frameworks, such as socio-materialism and the post-digital for understanding the digital component of digital play. The extent to which such continued reliance on theories of play, learning and development, many of which are pre-digital in their origins remains ontologically feasible as the post-digital continues to unfold will likely be evidenced in the literature over coming decades. Socio-materialism is already evident as

an explanation for the relationship between technologies, people, and things in ECEC and EYS settings (Kervin, Comber, & Woods, 2017; Pettersen, Arnseth, & Silseth, 2022). Recent literature does suggest also framing digital play beyond existing theories of play, learning and development to encompass concepts of agency whereby how young children use and engage with digital technologies is considered (Nolan et al., 2022). However, agency was not an identified theme in this review of literature. The third finding is pertinent given concerns about young children and digital technologies persist, especially in terms of health and wellbeing and addiction, which reflect a somewhat linear perspective of the relationships between children and technologies, e.g., associating use with physical activity and/or addiction, rather than notions of either play or the digital per se.

In addition to these three main findings, the literature identified for this review also showed that digital play was evidenced in multiple scenarios (e.g., homes, education settings, cars) with children and in relation to various stakeholders in their lives (peers, siblings, caregivers, educators, parents), and so it appears that digital play is not tethered specifically to education but embedded in children's life worlds. The extant literature regarding digital play from the emergence of the Apple iPad to 2022 suggests a predominate focus on understanding the affordances, features and concerns associated with digital play, predominantly around touchscreen and digital Apps. However, as AI, robotics, augmented reality, voice and facial recognition are embedded into the range of networked technologies used by children and their adults every day, there is a strong warrant for further research to develop a more contemporary theorisation of digital play, and to support educators, teachers, caregivers, and parents to understand dynamic and ever-changing digital play in action. New research should aim to better understand the embedded nature of digital play wherever it is enacted by children to inform future recommendations for parents, teachers, and policymakers.

Selection and Participation

There were no participants involved in this research.

Funding

This work was supported by the Australian Research Council Centre of Excellence [project number CE200100022].

CRediT authorship contribution statement

Celine Chu: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Visualization, Writing – original draft, Writing – review & editing. **Louise Paatsch:** Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Lisa Kervin:** Conceptualization, Methodology, Writing – review & editing. **Susan Edwards:** Conceptualization, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Celine Chu reports financial support was provided by Australian Research Council Centre of Excellence for the Digital Child.

Data availability

Data will be made available on request.

Acknowledgements

The authors wish to acknowledge Researchers Kelly Johnston and Brodie Brady, University of Wollongong, for their support during the search process of this review.

References

Aarsand, P., & Sorenssen, I. K. (2021). "And then it's my turn": Negotiating participation in tablet activities in early childhood education and care. *Journal of Early Childhood Literacy, 0*(0), 1–23. https://doi.org/10.1177/14687984211030614

Aberg, E. S., Lantz-Anderson, A., & Pramling, N. (2015). "I think it should be a little kind of exciting": A technology-mediated story- making activity in early childhood education. In S. Garvis, & N. Lemon (Eds.), *Understanding digital technologies and young children* (pp. 74–91). London: Routledge.

Aguiar, N. R., & Taylor, M. (2015). Children's concepts of the social affordances of a virtual dog and a stuffed dog. *Cognitive Development, 34*, 16–27. https://doi.org/10.1016/j.cogdev.2014.12.004

Alade, F., Lauricella, A., Beaudoin-Ryan, L., & Wartella, E. (2016). Measuring with Murray: Touchscreen technology and preschoolers' STEM learning. *Computers in Human Behavior, 62*, 433–441. https://doi.org/10.1016/j.chb.2016.03.080

Alemi, M., & Haeri, N. S. (2020). Robot-assisted instruction of L2 pragmatics: Effects on young EFL learners' speech act performance. *Language, Learning and Technology, 24*(2), 86–103. http://hdl.handle.net/10125/44727.

Alzubi, T., Fernandez, R., Flores, J., Duran, M., & Cotos, J. M. (2018). Improving the working memory during early childhood education through the use of an interactive gesture game-based learning approach. *IEEE Access, 6*, 53998–54009. https://doi.org/10.1109/ACCESS.2018.2870575

Amorim, A. N., Jeon, L., Abel, Y., Albuquerque, E. X. S., Soares, M., Silva, V. C., et al. (2022). Escribo play learning games can foster early reading and writing for low-income kindergarten children. *Computers & Education, 177*, 1–13. https://doi.org/10.1016/j.compedu.2021.104364

Amorim, A. N., Jeon, L., Abel, Y., Felisberto, E. F., Barbosa, L. N. F., & Dias, N. M. (2020). Using Escribo Play video games to improve phonological awareness, early reading, and writing in preschool. *Educational Researcher, 49*(3), 188–197. https://doi.org/10.3102/0013189X20909824

Arent, K., Kruk-Lasocka, J., Niemiec, T., & Szczepanowski, R. (2019). Social robot in diagnosis of autism among preschool children. In *2019 24th international conference on methods and models in automation and robotics (MMAR)* (pp. 652–656). IEEE. https://doi.org/10.1109/MMAR.2019.8864666.

Arnott, L. (2016). An ecological exploration of young children's digital play: Framing children's social experiences with technologies in early childhood. *Early Years, 36*(3), 271–288. https://doi.org/10.1080/09575146.2016.1181049

Arnott, L., Grogan, D., & Duncan, P. (2016). Lessons from using iPads to understand young children's creativity. *Contemporary Issues in Early Childhood, 17*(2), 157–173. https://doi.org/10.1177/1463949116633347

Axelsson, A., Andersson, R., & Gulz, A. (2016). Scaffolding executive function capabilities via play-&-learn software for Preschoolers. *Journal of Educational Psychology, 108*(7), 969–981. https://doi.org/10.1037/edu0000099

Aydin, B., Oflu, A., & Yalcin, S. S. (2021). Evaluation of video game playing status in school-age children with various variables. *Turkish Archives of Pediatrics, 56*(2), 136–140. https://doi.org/10.5152/TurkArchPediatr.2020.20092

Bai, Z., Blackwell, A. F., & Coulouris, G. (2015). Using augmented reality to elicit pretend play for children with autism. *IEEE Transactions on Visualization and Computer Graphics, 21*(5), 598–610. https://doi.org/10.1109/TVCG.2014.2385092

Bang, C., Nam, Y., Ko, E. J., Lee, W., Kim, B., Choi, Y., et al. (2019). A serious game–derived index for detecting children with heterogeneous developmental disabilities: Randomized controlled trial. *JMIR Serious Games, 7*(4), 1–13. http://games.jmir.org/2019/4/e14924/.

Barnett, L. M., Hinkley, T., Okely, A. D., Hesketh, K., & Salmon, J. (2012). Use of electronic games by young children and fundamental movement skills. *Perceptual and Motor Skills, 114*(3), 1023–1034. https://doi.org/10.2466/10.13.PMS.114.3.1023-1034

Barsom, R. M. M., & Ahmed, E. A. M. (2021). The reality of playing e-games during the period of domestic ban and its impact on the early childhood children' developmental domains from mothers' point of view. *Elementary Education Online, 20*(6), 366–390. https://doi.org/10.17051/ilkonline.2021.06.039

Bird, J., & Edwards, S. (2015). Children learning to use technologies through play: A digital play framework. *British Journal of Educational Technology, 46*(6), 1149–1160. https://doi.org/10.1111/bjet.12191

Byun, M., & Seomun, G. (2021). Development of toddlers' smartphone flow state scale: Parent report form. *International Journal of Environmental Research and Public Health, 18*, 1–15. https://doi.org/10.3390/ijerph182211833

Caceffo, R., Gonçalves, D. A., Bonacin, R., Cesar dos Reis, J., José, A., Valente, J. A., et al. (2022). Children's social interactions within a socioenactive scenario. *Computers & Education, 176*, 1–18. https://doi.org/10.1016/j.compedu.2021.104324

Chaudron, S., Di Gioia, R., & Gemo, M. (2018). *Young children (0–8) and digital technology, a qualitative study across Europe* (Vol. 29070). EUR. https://doi.org/10.2760/294383

Chmiliar, L. (2017). Improving learning outcomes: The iPad and preschool children with disabilities. *Frontiers in Psychology, 8*, 1–11. https://doi.org/10.3389/fpsyg.2017.00660

Covidence Systematic Review Software. Covidence [computer software]. Veritas Health Innovation.

Coyle, E. F., & Liben, L. S. (2016). Affecting girls' activity and job interests through play: The moderating roles of personal gender salience and game characteristics. *Child Development, 87*(2), 414–428. https://doi.org/10.1111/cdev.12463

Danby, S., Davidson, C., Theobald, M., Houen, S., & Thorpe, K. (2017). Pretend play and technology: Young children making sense of their everyday social worlds. In S. Lynch, D. Pike, & C. Beckett (Eds.), *Multidisciplinary perspectives on play from birth and beyond* (pp. 231–245). Singapore: Springer. https://doi.org/10.1007/978-981-10-2643-0_14.

Danby, S., Evaldsson, A., Melander, H., & Aarsand, P. (2018). Situated collaboration and problem solving in young children's digital gameplay. *British Journal of Educational Technology, 49*(5), 959–972. https://doi.org/10.1111/bjet.12636

Dias, M., & Agante, L. (2011). Can advergames boost children's healthier eating habits? A comparison between healthy and non-healthy food. *Journal of Consumer Behaviour, 10*, 152–160. https://doi.org/10.1002/cb.359

Disney, L., & Geng, G. (2017). A case study of young children's use of iPad for digital storytelling for a study of self. In W. Chen, J.-C. Yang, A. F. Mohd Ayub, S. L. Wong, & A. Mitrovic (Eds.), *25th international conference on computers in education: Technology and innovation: Computer-based educational systems for the 21st century: Main conference proceedings* (pp. 614–619). Asia-Pacific Society for Computers in Education.

Dore, R. A., Shirilla, M., Hopkins, E., Collins, M., Scott, M., Schatz, J., et al. (2019). Education in the app store: Using a mobile game to support U.S. preschoolers' vocabulary learning. *Journal of Children and Media, 13*(4), 452–471. https://doi.org/10.1080/17482798.2019.1650788

Dunn, J., Gray, C., Moffett, P., & Mitchell, D. (2018). 'It's more funner than doing work': Children's perspectives on using tablet computers in the early years of school. *Early Child Development and Care, 188*(6), 819–831. https://doi.org/10.1080/03004430.2016.1238824

Eckhoff, A. (2017). Images of play experiences through a child's lens: An exploration of play and digital media with young children. *International Journal of Early Childhood, 49*, 113–129. https://doi.org/10.1007/s13158-017-0181-9

Edwards, S. (2021). Digital play and technical code: What new knowledge formations are possible? *Learning, Media and Technology, 46*(3), 306–319. https://doi.org/10.1080/17439884.2021.1890612

Edwards, S. (2023). Concepts for early childhood education and care in the postdigital. *Postdigital Science and Education, 5*, 777–798. https://doi.org/10.1007/s42438-022-00356-7, 2023.

Elimelech, A., & Aram, D. (2019). Using a digital spelling game for promoting alphabetic knowledge of preschoolers: The contribution of auditory and visual supports. *Reading Research Quarterly, 55*(2), 235–250. https://doi.org/10.1002/rrq.264

Erdogan, N. I., Johnson, J. E., Dong, P. I., & Qiu, Z. (2019). Do parents prefer digital play? Examination of parental preferences and beliefs in four nations. *Early Childhood Education Journal, 47*, 131–142. https://doi.org/10.1007/s10643-018-0901-2

Fang, M., Tapalova, O., Zhiyenbayeva, N., & Kozlovskaya, S. (2022). Impact of digital game-based learning on the social competence and behavior of preschoolers. *Education and Information Technologies, 27*, 3065–3078. https://doi.org/10.1007/s10639-021-10737-3

Fantozzi, V. B., Johnson, C., & Scherfen, A. (2017). One classroom, one iPad, many stories. *The Reading Teacher, 71*(6), 681–689. https://doi.org/10.1002/trtr.1651

Fleer, M. (2014). The demands and motives afforded through digital play in early childhood activity settings. *Learning, Culture and Social Interaction, 3*, 202–209.

Fridin, M. (2014). Storytelling by a kindergarten social assistive robot: A tool for constructive learning in preschool education. *Computers & Education, 70*, 53–64. https://doi.org/10.1016/j.compedu.2013.07.043

Froes, I. C. G. (2015). Once upon a tablet: A school toy in the making. In M. Antona, & C. Stephanidis (Eds.), *Lecture notes in computer science: Vol. 9177. Universal access in human- computer interaction. Access to learning, health and well-being* (pp. 43–53). Cham: Springer. https://doi.org/10.1007/978-3-319-20684-4_5.

Given, L. M., Winkler, D. C., Willson, R., Davidson, C., Danby, S., & Thorpe, K. (2016). Watching young children "play" with Information technology: Everyday life information seeking in the home. *Library & Information Science Research, 38*, 344–352. https://doi.org/10.1016/j.lisr.2016.11.007

Gou, H., & Dezuanni, M. (2018). Towards understanding young children's digital lives in China and Australia. *Comunicar, 57*(XXVI), 81–90. https://doi.org/10.3916/C57-2018-08

Gozum, A. I. C., & Kandir, A. (2021). Digital games pre-schoolers play: Parental mediation and examination of educational content. *Education and Information Technologies, 26*, 3293–3326. https://doi.org/10.1007/s10639-020-10382-2

Grieshaber, S., & Barnes, S. (2021). Playing with the politics of play. In T. Kinard, & G. S. Cannella (Eds.), *Childhoods in more just worlds: An international handbook* (pp. 259–277). Myers Education Press.

Gulliford, A., Walton, J., Allison, K., & Pitchford, N. (2021). A qualitative investigation of implementation of app-based maths instruction for young learners. *Educational and Child Psychology, 38*(3), 90–108. https://doi.org/10.53841/bpsecp.2021.38.3.90

Gulz, A., Londos, L., & Haake, M. (2020). Preschoolers' understanding of a teachable agent-based game in early mathematics as reflected in their gaze behaviors – an experimental study. *International Journal of Artificial Intelligence in Education, 30*, 38–73. https://doi.org/10.1007/s40593-020-00193-4

Han, J., Jo, M., Hyun, E., & So, H. (2015). Examining young children's perception toward augmented reality-infused dramatic play. *Educational Technology Research & Development, 63*, 455–474. https://doi.org/10.1007/s11423-015-9374-9

Henricks, T. (2008). The nature of play. *American Journal of Play, 1*(2), 157–180.

Herodotou, C. (2018). Mobile games and science learning: A comparative study of 4 and 5 years old playing the game angry birds. *British Journal of Educational Technology, 49*(1), 6–16. https://doi.org/10.1111/bjet.12546

Ho, A., Lee, J., Wood, E., Kassies, S., & Heinbuck, C. (2018). Tap, swipe, and build: Parental spatial input during iPad® and toy play. *Infant and Child Development, 27*(1), 1–16. https://doi.org/10.1002/icd.2061

Hollenstein, L., Thurnheer, S., & Vogt, F. (2022). Problem solving and digital transformation: Acquiring skills through pretend play in kindergarten. *Education Sciences, 12*(2), 1–18. https://doi.org/10.3390/educsci12020092

Hong, Q. N., Fàbregues, S., Bartlett, G., Boardman, F., Cargo, M., Dagenais, P., et al. (2018). The Mixed Methods Appraisal Tool (MMAT) version 2018 for information professionals and researchers. *Education for Information, 34*(4), 285–291. https://doi.org/10.3233/EFI-180221

Howie, E. K., Coenen, P., Campbell, A. C., Ranelli, S., & Straker, L. M. (2017). Head, trunk and arm posture amplitude and variation, muscle activity, sedentariness and physical activity of 3 to 5 year-old children during tablet computer use compared to television watching and toy play. *Applied Ergonomics, 65*, 41–50. https://doi.org/10.1016/j.apergo.2017.05.011

Huh, Y. J. (2017). Rethinking young children's digital game play outside of the home as a means of coping with modern life. *Early Child Development and Care, 187*(5–6), 1042–1054. https://doi.org/10.1080/03004430.2016.1237512

Isikoglu, N., Erol, A., Atan, A., & Aytekin, S. (2021). A qualitative case study about overuse of digital play at home. *Current Psychology, 42*, 1676–1686. https://doi.org/10.1007/s12144-021-01442-y

Jarusriboonchai, P., Almeida, T., Meissner, J. L., & Balaam, M. (2019). Understanding children's free play in primary schools. In *The 9th international conference on communities & technologies - transforming communities*. Association for Computing Machinery. https://doi.org/10.1145/3328320.3328384.

Johnston, K., Highfield, K., & Hadley, F. (2018). Supporting young children as digital citizens: The importance of shared understandings of technology to support integration in play-based learning. *British Journal of Educational Technology, 49*(5), 896–910. https://doi.org/10.1111/bjet.12664

Kalabina, I. A., & Progackaya, T. K. (2021). Defining digital competence for older preschool children. *Psychology in Russia: State of the Art, 14*(4), 38–54. https://doi.org/10.11621/pir.2021

Karno, D., & Hatcher, B. (2020). Building computer supported collaborative learning environments in early childhood classrooms. *Educational Technology Research & Development, 68*, 249–267. https://doi.org/10.1007/s11423-019-09686-z

Kervin, L. (2016). Powerful and playful literacy learning with digital technologies. *Australian Journal of Language and Literacy, 39*(1), 64–73.

Kervin, L., Comber, B., & Woods, A. (2017). Toward a sociomaterial understanding of writing experiences incorporating digital Technology in an early childhood classroom. *Literacy research: Theory, method, and practice, 66*(1), 183–197.

Kervin, L., Verenikina, I., & Rivera, C. (2018). Digital play and learning in the home: Families' perspective. In S. J. Danby, M. Fleer, C. Davidson, & M. Hatzigianni (Eds.), *Digital childhoods. International perspectives on early childhood education and development* (pp. 117–130). Singapore: Springer. https://doi.org/10.1007/978-981-10-6484-5_8.

Kewalramani, S., & Havu-Nuutinen, S. (2019). Preschool teachers' beliefs and pedagogical practices in the integration of technology: A case for engaging young children in scientific inquiry. *Eurasia Journal of Mathematics, Science and Technology Education, 15*(12), 1–13. https://doi.org/10.29333/ejmste/109949

Kewalramani, S., Kidman, G., & Palaiologou, I. (2021). Using artificial intelligence (AI)-interfaced robotic toys in early childhood settings: A case for children's inquiry literacy. *European Early Childhood Education Research Journal, 29*(5), 652–668. https://doi.org/10.1080/1350293X.2021.1968458

Kewalramani, S., Palaiologou, I., Arnott, L., & Dardanou, M. (2020). The integration of the internet of toys in early childhood education: A platform for multi-layered interactions. *European Early Childhood Education Research Journal, 28*(2), 197–213. https://doi.org/10.1080/1350293X.2020.1735738

Kewalramani, S., Palaiologou, I., Dardanou, M., Allen, K., & Phillipson, S. (2021). Using robotic toys in early childhood education to support children's social and emotional competencies. *Australasian Journal of Early Childhood, 46*(4), 355–369. https://doi.org/10.1177/18369391211056668

Kewalramani, S., & Veresov, N. (2021). Multimodal creative inquiry: Theorising a new approach for children's science meaning-making in early childhood education. *Research in Science Education, 52*, 927–947. https://doi.org/10.1007/s11165-021-10029-3

Kim, Y., & Tscholl, M. (2021). Young children's embodied interactions with a social robot. *Educational Technology Research & Development, 69*, 2059–2081. https://doi.org/10.1007/s11423-021-09978-3

Kumpulainen, K., Byman, J., Renlund, J., & Wong, C. C. (2020). Children's augmented storying in, with and for nature. *Education Sciences, 10*(6), 149. https://doi.org/10.3390/educsci10060149

Lafton, T. (2021). Becoming clowns: How do digital technologies contribute to young children's play? *Contemporary Issues in Early Childhood, 22*(3), 221–231. https://doi.org/10.1177/1463949119864207

Lagerlof, P., Wallerstedt, C., & Pramling, N. (2013). Engaging children's participation in and around a new music technology through playful framing. *International Journal of Early Years Education, 21*(4), 325–335. https://doi.org/10.1080/09669760.2013.867170

Laranjeiro, D. (2021). Development of game-based m-learning apps for preschoolers. *Education Sciences, 11*, 229. https://doi.org/10.3390/educsci11050229

Lawrence, S. M. (2018). Preschool children and iPads: Observations of social interactions during digital play. *Early Education & Development, 29*(2), 207–228. https://doi.org/10.1080/10409289.2017.1379303

Lee, J., & Wood, E. (2021). Examining parent–child spatial play interaction using traditional toys and touch screen tablets. *Parenting, 21*(4), 304–331. https://doi.org/10.1080/15295192.2020.1811062

Leung, S. K. Y., Choi, K. W. Y., & Yuen, M. (2020). Video art as digital play for young children. *British Journal of Educational Technology, 51*(2), 531–554. https://doi.org/10.1111/bjet.12877

Lim, E. M. (2012). Patterns of kindergarten children's social interaction with peers in the computer area. *Computer-Supported Collaborative Learning, 7*, 399–421. https://doi.org/10.1007/s11412-012-9152-1

Lorusso, M. L., Biffi, E., Molteni, M., & Reni, G. (2018). Exploring the learnability and usability of a near field communication-based application for semantic enrichment in children with language disorders. *Assistive Technology, 30*(1), 39–50. https://doi.org/10.1080/10400435.2016.1253046

Lowrie, T., & Larkin, K. (2020). Experience, represent, apply (era): A heuristic for digital engagement in the early years. *British Journal of Educational Technology, 51*(1), 131–147.

Lundtofte, T. E., Odgaard, A. B., & Skovbjerg, H. M. (2019). Absorbency and utensilency: A spectrum for analysing children's digital play practices. *Global Studies of Childhood, 9*(4), 335–347. https://doi.org/10.1177/2043610619881457

Mairena, M. A., Mora-Guiard, J., Malinverni, L., Padillo, V., Valero, L., Hervas, A., et al. (2019). A full-body interactive videogame used as a tool to foster social initiation conducts in children with autism spectrum disorders. *Research in Autism Spectrum Disorders, 67*. https://doi.org/10.1016/j.rasd.2019.101438

Manessis, D. (2014). The importance of future kindergarten teachers' beliefs about the usefulness of games based learning. *International Journal of Game-Based Learning, 4*(1), 78–90. https://doi.org/10.4018/IJGBL.2014010105

Marklund, L. (2022). Swedish preschool teachers' perceptions about digital play in a workplace-learning context. *Early Years, 42*(2), 167–181. https://doi.org/10.1080/09575146.2019.1658065

Marsh, J. (2017). The internet of toys: A posthuman and multimodal analysis of connected play. *Teachers College Record, 119*, 1–32.

Marsh, J. (2019). Researching young children's play in the post-digital age: Questions of method. In *The Routledge international handbook of learning with technology in early childhood* (pp. 157–169). Routledge.

Marsh, J., Lahmar, J., Plowman, L., Yamada-Rice, D., Bishop, J., & Scott, F. (2021). Under threes' play with tablets. *Journal of Early Childhood Research, 19*(3), 283–297. https://doi.org/10.1177/1476718X20966688

Marsh, J., Plowman, L., Yamada-Rice, D., Bishop, J., & Scott, F. (2016). Digital play: A new classification. *Early Years, 36*(3), 242–253. https://doi.org/10.1080/09575146.2016.1167675

McKee, L., & Heydon, R. (2020). 'Enabled to play, enabled to explore': Children's civic engagement, literacies, and teacher professional learning. *Discourse: Studies in the Cultural Politics of Education, 41*(5), 782–798. https://doi.org/10.1080/01596306.2020.1769939

McKenzie, J. E., Brennan, S. E., Ryan, R. E., Thomson, H. J., Johnston, R. V., & Thomas, J. (2022). Defining the criteria for including studies and how they will be grouped for the synthesis. In J. P. T. Higgins, J. Thomas, J. Chandler, M. Cumpston, T. Li, M. J. Page, et al. (Eds.), *Cochrane handbook for systematic reviews of interventions*. Cochrane version 6.3. https://training.cochrane.org/handbook.

Mertala, P. (2016). Fun and games – Finnish children's ideas for the use of digital media in preschool. *Nordic Journal of Digital Literacy, 11*(4), 207–226. https://doi.org/10.18261/issn.1891-943x-2016-04-01

Miller, T. (2018). Developing numeracy skills using interactive technology in a play-based learning environment. *International Journal of STEM Education, 5*(39), 1–11. https://doi.org/10.1186/s40594-018-0135-2

Moawad, R. A. M. (2017). Computer tablet games' effect on young children's self-concept. *International Education Studies, 10*(3), 116–124. https://doi.org/10.5539/ies.v10n3p116

Moore, H. C., & Adair, J. K. (2015). "I'm just playing iPad": Comparing prekindergarteners' and preservice teachers' social interactions while using tablets for learning. *Journal of Early Childhood Teacher Education, 36*, 362–378. https://doi.org/10.1080/10901027.2015.1104763

Murcia, K., Pepper, C., Joubert, M., Cross, E., & Wilson, S. (2020). A framework for identifying and developing children's creative thinking while coding with digital technologies. *Issues in Educational Research, 30*(4), 1395–1417. http://www.iier.org.au/iier30/murcia2.pdf.

Muslimah, & Syamsudin, A. (2020). Digital learning for early years in urban family: A qualitative exploratory study across four urban family. *ICLIQE 2020: Proceedings of the 4th International Conference on Learning Innovation and Quality Education, 85*, 1–9. https://doi.org/10.1145/3452144.3452228

Najoua, T., & Mohamed, E. A. (2020). A new evaluation technique through serious games for children with ASD. *iJet, 15*(11), 202–217.

Nevski, E., & Siibak, A. (2016). The role of parents and parental mediation on 0–3-year olds' digital play with smart devices: Estonian parents' attitudes and practices. *Early Years, 36*(3), 227–241.

Nilsen, M., Lundin, M., Wallerstedt, C., & Pramling, N. (2021). Evolving and re-mediated activities when preschool children play analogue and digital memory games. *Early Years, 41*(2–3), 232–247. https://doi.org/10.1080/09575146.2018.1460803

Nolan, A., Edwards, S., Salamon, A., Straker, L., Grieshaber, S., Skouteris, H., et al. (2022). Young children's agency with digital technologies. *Children & Society, 36*, 541–563. https://doi.org/10.1111/chso.12512

Nuttall, J., Edwards, S., Lee, S., Mantilla, A., & Wood, E. (2013). The implications of young children's digital consumerist play for changing the kindergarten curriculum. *Cultural-Historical Psychology, 9*(2), 54–63.

O'Brien, B. C., Harris, I. B., Beckman, T. J., Reed, D. A., & Cook, D. A. (2014). Standards for reporting qualitative research: A synthesis of recommendations. *Academic Medicine, 89*(9), 1245–1251.

Odgaard, A. B. (2022). What is the problem? A situated account of computational thinking as problem-solving in two Danish preschools. *Künstliche Intelligenz, 36*, 47–57. https://doi.org/10.1007/s13218-021-00752-4

Oliemat, E., Ihmeideh, F., & Alkhawaldeh, M. (2018). The use of touch-screen tablets in early childhood: Children's knowledge, skills, and attitudes towards tablet technology. *Children and Youth Services Review, 88*, 591–597. https://doi.org/10.1016/j.childyouth.2018.03.028

Oqvist, A., & Hogstrom, P. (2018). Don't ask me why: Preschool teachers' knowledge in technology as a determinant of leadership behavior. *Journal of Technology Education, 29*(2), 4–19.

Palaiologou, I., Kewalramani, S., & Dardanou, M. (2021). Make-believe play with the internet of toys: A case for multimodal playscapes. *British Journal of Educational Technology, 52*, 2100–2117. https://doi.org/10.1111/bjet.13110

Peppler, K., Wohlwend, K., Thompson, N., Tan, V., & Thomas, A. (2019). Squishing circuits: Circuitry learning with electronics and playdough in early childhood. *Journal of Science Education and Technology, 28*, 118–132. https://doi.org/10.1007/s10956-018-9752-2

Perone, S., Anderson, A. J., & Zelazo, P. D. (2021). The influence of parental guidance on video game performance, exploration, and cortical activity in 5-year-old children. *Cognitive Development, 60*, 1–16. https://doi.org/10.1016/j.cogdev.2021.101126

Pettersen, K., Arnseth, H. C., & Silseth, K. (2022). Playing Minecraft: Young children's postdigital play. *Journal of Early Childhood Literacy*, Article 14687984221118977.

Pila, S., Piper, A. M., Lauricella, A., & Wartella, E. (2020). Preschoolers' STEM learning on a haptic enabled tablet. *Multimodal Technologies and Interaction, 4*(87), 1–25. https://doi.org/10.3390/mti4040087

Putnam, M. M., Cotto, C. E., & Calvert, S. L. (2018). Character apps for children's snacks: Effects of character awareness on snack selection and consumption patterns. *Games for Health Journal: Research, Development, and Clinical Applications, 7*(2), 116–120. https://doi.org/10.1089/g4h.2017.0097

Ronimus, M., Eklund, K., Pesu, L., & Lyytinen, H. (2019). Supporting struggling readers with digital game-based learning. *Educational Technology Research & Development, 67*, 639–663. https://doi.org/10.1007/s11423-019-09658-3

Rosa, R. L., Ridgers, N. D., & Barnett, L. M. (2013). Development and use of an observation tool for active gaming and movement (OTAGM) to measure children's movement skill components during active video game play. *Perceptual & Motor Skills: Physical Development & Measurement, 117*(3), 935–949. https://doi.org/10.2466/03.25.PMS.117x28z4

Russo-Johnson, C., Troseth, G., Duncan, C., & Mesghina, A. (2017). All tapped out: Touchscreen interactivity and young children's word learning. *Frontiers in Psychology, 8*(578), 1–15. https://doi.org/10.3389/fpsyg.2017.00578

Sakr, M., & Scollan, A. (2019). The screen and the sand-timer: The integration of the interactive whiteboard into an early years free-flow learning environment. *Journal of Early Childhood Research, 17*(3), 190–204. https://doi.org/10.1177/1476718X19851538

Sanchez-Morales, A., Durand-Rivera, J. A., & Martinez-Gonzalez, C. L. (2020). Usability evaluation of a tangible user interface and serious game for identification of cognitive deficiencies in preschool children. *International Journal of Advanced Computer Science and Applications, 11*(6), 486–493.

Schacter, J., Shih, J., Allen, C. M., DeVaul, L., Adkins, A. B., Ito, T., et al. (2016). Math shelf: A randomized trial of a prekindergarten tablet number sense curriculum. *Early Education & Development, 27*(1), 74–88. https://doi.org/10.1080/10409289.2015.1057462

Schenke, K., Redman, E. J. K. H., Chung, G. K. W. K., Chang, S. M., Feng, T., Parks, C. B., et al. (2020). Does "measure up!" measure up? Evaluation of an iPad app to teach preschoolers measurement concepts. *Computers & Education, 146*, 1–12. https://doi.org/10.1016/j.compedu.2019.103749

the CareToy Consortium Sgandurra, G., Bartalena, L., Cecchi, F., Cioni, G., Giampietri, M., Greisen, G., et al. (2016). A pilot study on early home-based intervention through an intelligent baby gym (CareToy) in preterm infants. *Research in Developmental Disabilities, 53–54*(June-July 2016), 32–42. https://doi.org/10.1016/j.ridd.2016.01.013.

Shoshani, A., Nelke, S., & Girtler, I. (2022). Tablet applications as socializing platforms: The effects of prosocial touch screen applications on young children's prosocial behavior. *Computers in Human Behavior, 127*, 1–14. https://doi.org/10.1016/j.chb.2021.107077

So, W., Cheng, C., Lam, W., Huang, Y., Ng, K., Tung, H., et al. (2020). A robot-based play-drama intervention may improve the joint attention and functional play behaviors of Chinese-speaking preschoolers with autism spectrum disorder: A pilot study. *Journal of Autism and Developmental Disorders, 50*, 467–481. https://doi.org/10.1007/s10803-019-04270-z

So, W., Cheng, C., Lam, W., Wong, T., Law, W., Huang, Y., et al. (2019). Robot-based play-drama intervention may improve the narrative abilities of Chinese-speaking preschoolers with autism spectrum disorder. *Research in Developmental Disabilities, 95*, 1–15. https://doi.org/10.1016/j.ridd.2019.103515

Sosa, A. V. (2016). Association of the type of toy used during play with the quantity and quality of parent-infant communication. *JAMA Pediatrics, 170*(2), 132–137. https://doi.org/10.1001/jamapediatrics.2015.3753

Sundqvist, P. (2021). Characterizations of preschool technology education: Analyses of seven individual preschool teachers' and childcare attendants' descriptions of their teaching. *International Journal of Technology and Design Education, 32*. https://doi.org/10.1007/s10798-021-09678-2

Taheri, A., Meghdari, A., Alemi, M., & Pouretemad, H. (2018). Clinical interventions of social humanoid robots in the treatment of a set of high- and low-functioning autistic Iranian twins. *Scientia Iranica, 25*(3), 1197–1214. https://doi.org/10.24200/sci.2017.4337

United Nations Educational, Scientific and Cultural Organization. (2022). Early childhood care and education. https://www.unesco.org/en/early-childhood-education.

van der Westhuizen, L. M., & Hannaway, D. M. (2021). Digital play for language development in the early grades. *South African Journal of Childhood Education, 11*(1), 1–8. https://doi.org/10.4102/sajce.v11i1.925

Verdine, B. N., Zimmermann, L., Foster, L., Marzouk, M. A., Golinkoff, R. M., Kathy Hirsh-Pasek, K. H., et al. (2019). Effects of geometric toy design on parent-child interactions and spatial language. *Early Childhood Research Quarterly, 46*, 126–141. https://doi.org/10.1016/j.ecresq.2018.03.015

Verenikina, I., & Kervin, L. (2011). iPads, digital play and pre-schoolers. *He Kupu, 2*(5), 4–16.

Verenikina, I., Siraj, I., & Kervin, L. (2018). Learning through digital play in the Australian context of early childhood education and care. In N. Veraksa, S. Sheridan, T. Bertram, & C. Pascal (Eds.), *Vygotsky's theory in early childhood education and research* (pp. 166–178). London: Routledge.

Vogt, F., & Hollenstein, L. (2021). Exploring digital transformation through pretend play in kindergarten. *British Journal of Educational Technology, 52*, 2130–2144. https://doi.org/10.1111/bjet.13142

Wohlwend, K. E. (2017). Who gets to play? Access, popular media and participatory literacies. *Early Years, 37*(1), 62–76. https://doi.org/10.1080/09575146.2016.1219699

Wooldridge, M. B., & Shapka, J. (2012). Playing with technology: Mother–toddler interaction scores lower during play with electronic toys. *Journal of Applied Developmental Psychology, 33*, 211–218. https://doi.org/10.1016/j.appdev.2012.05.005

Wu, C. S. T., Fowler, C., Lam, W. Y. Y., Wong, H. T., Wong, C. H. M., & Loke, A. Y. (2014). Parenting approaches and digital technology use of preschool age children in a Chinese community. *Italian Journal of Pediatrics, 40*(44), 1–8. http://www.ijponline.net/content/40/1/44.

Yalcin, S. S., Caylan, N., Nergiz, M. E., Oflu, A., Yildiz, D., Tezol, O., et al. (2021). Video game playing among preschoolers: Prevalence and home environment in three provinces from Turkey. *International Journal of Environmental Health Research, 32*(10), 2233–2246. https://doi.org/10.1080/09603123.2021.1950653

Yasbiati, Y., Gandana, G., & Rahman, T. (2019). Educative and digital based game (PowerPoint) game games as a stimulation method of discussion skill development early childhood. In *IOP conference series: Journal of physics: Conference series* (pp. 1–5). IOP Publishing. https://doi.org/10.1088/1742-6596/1318/1/012048.

Yelland, N., & Gilbert, C. (2018). Transformative technologies and play in the early years: Using tablets for new learning. *Global Studies of Childhood, 8*(2), 152–161. https://doi.org/10.1177/2043610617734985

Yilmaz, R. M. (2016). Educational magic toys developed with augmented reality technology for early childhood education. *Computers in Human Behavior, 54*, 240–248. https://doi.org/10.1016/j.chb.2015.07.040

Zippert, E. L., Daubert, E. N., Scalise, N. R., Noreen, G. D., & Ramani, G. B. (2019). "Tap space number three": Promoting math talk during parent-child tablet play. *Developmental Psychology, 55*(8), 1605–1614. https://doi.org/10.1037/dev0000769